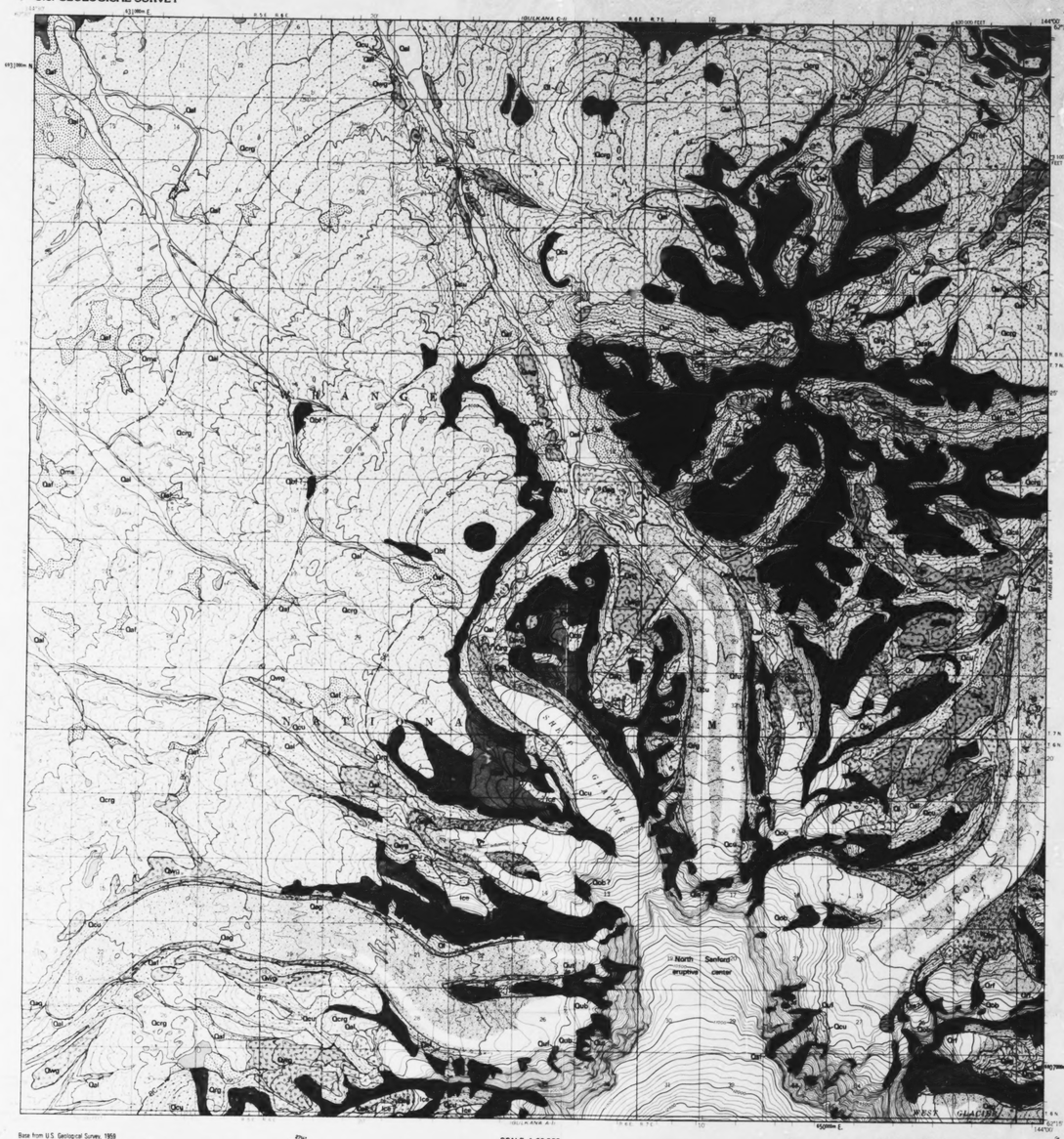
DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY



Base from U.S. Geological Survey, 1958
10,000-foot grid based on Alaska coordinate system, zone 3
1000-meter Universal Transverse Mercator grid ticks, zone 8, shown in blue

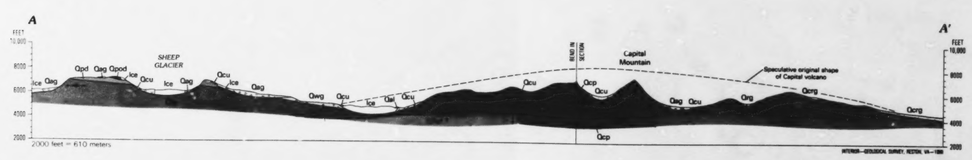
SCALE 1:63 360

1 ½ 0 1 2 3 4 MILES
1 5 0 1 2 3 4 KILOMETERS

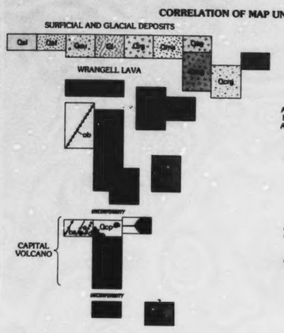
CONTOUR INTERVAL 100 FEET
NATIONAL GEODETIC VERTICAL DATUM OF 1929

QUADRANGLE LOCATION

Bedrock geology by D. H. Richter, 1981–82; J. G. Smith, 1981, and J. C. Ratté and W. P. Leeman, 1982, in 8 helicopter-supported days. Glacial and surficial geology by H. R. Schmoll and L. A. Yehle chiefly by air photo interpretation supported by 2 days of helicopter field checking in 1983



CORRELATION OF MAP UNITS



DESCRIPTION OF MAP UNITS

Alluvial deposits (Holocene)

Qal **Alluvium in streams**—Mainly in active flood plains and terraces of major streams and some minor streams. Includes outwash in channels and aprons related to older phase of the Alaskan glaciation. Chiefly sand and gravel, local cobbles and boulders

Qaf **Alluvium in fans**—Includes large broad fans in low-lying areas and some fans and cones on steep mountain slopes mainly along major streams. Also includes some fans, containing mostly fine-grained material, along minor streams on gentle slopes of Mount Sanford. Chiefly sand, gravel, and boulders

Colluvial deposits (Holocene and Pleistocene)

Qcu **Colluvium, undifferentiated**—Chiefly talus but includes deposits of small landslides, rock glaciers, and other mass-wastage processes, generally includes alluvium in numerous small fans and cones. May also include remnants of valley-glacier moraines. Occurs mainly on steep valley walls in bedrock. Chiefly unsorted silt, sand, gravel, and boulders

Qls **Landslide deposits**—Includes large slump and block-glide deposits and some large debris avalanches in both bedrock and glacial deposits

Qrg **Rock-glacier deposits (Holocene and Pleistocene)**—Includes deposits in active rock glaciers, which have well-defined lobate and tongue-shaped forms, small coalescing rock glaciers, which form linear ridges along bases of steep slopes, and inactive rock glaciers, which have smooth forms. Chiefly angular blocks and diamicton

Qmrsf **Minersl-spring(?) deposits (Holocene and Pleistocene)**—Deposits in two conical landforms that may have originated by reworking of glacial deposits through mineral-spring activity; only more northerly of landforms contains a summ?r lake. Deposits may be similar to those in larger and better formed cones several kilometers southwest (Nichols and Yehle, 1961)

Valley-glacier deposits

Qtrf **Drift of Alaskan glaciation (Holocene)**—Includes end and lateral moraines of the younger (Tunnel) phase of Alaskan glaciation, deposited after recession of existing glaciers, and end moraines of older (Tustamena?) phase of Alaskan glaciation. Diamicton and rubble, local gravel

Drift of Wisconsin glaciation (Pleistocene)—End, lateral, and ground moraines and local outwash of younger and older phases of Drop Creek moraines (Schmoll, 1984). Locally modified by mass slumping and other colluvial and alluvial processes. Diamicton and boulders, local gravel and sand

Qcrg **Copper River basin glacier deposits (Pleistocene)**—Includes Cobb Lakes, Boulder Creek, and Sanford-Copper lateral moraines (Schmoll, 1984), the boundaries of which are shown by line symbol. Also includes ground-moraine, esker, kame, channel, valley-fill, and outwash deposits related to these moraines as well as older ground moraine. Occurs mainly on broad slopes of Mount Sanford and Capital Mountain. Deposits locally extensively modified by colluvial processes, including downslope movement, debris flow, solifluction, and creep, and by stream action. Chiefly diamicton and rubble, local sand and gravel

Glaciolacustrine deposits (Pleistocene)—Deposits on floor and sloping shore areas of glacial Lake Atna. Chiefly interbedded clay, silt, and fine sand, locally pebbly. Exposed only in extreme northwest corner of quadrangle, below elevation of 2,500 ft

Wrangell Lava

Olivine andesite flow (Pleistocene)—Medium-gray, sparsely porphyritic lava containing small (0.5 mm) phenocrysts of olivine in a trachytic groundmass of plagioclase, hypersthene, and opaque minerals. Thick (100 m) single flow, exhibiting intricately contorted columnar joints, that may have flowed down valley beneath ice. Exposed only in secs. 1 and 2, T. 6 N., R. 7 E.

Young Sanford flows (Pleistocene)—Exposed only high in the cirque wall at the head of Drop Glacier. Flows appear to drape over older flat-lying flows (unit Qaf) and are probably young lavas from the main cone of Mount Sanford volcano, whose summit is about 6 km south in Gulkana A–1 quadrangle

Olivine basalt cinder cones (Pleistocene)—Small cinder cones, some with small-volume vesicular and scoriaceous flows, appear to be restricted to zone encircling Capital Mountain volcano. Cones consist of reddish-brown cinder, bombs, and irregular masses of spatter; a few still exhibit their original topographic form. Nonoxidized rocks are dark-gray, porphyritic and microporphyritic lava containing phenocrysts of calcic plagioclase (1–20 percent, 0.4–1.5 mm), olivine (1–10 percent, 0.2–1 mm), and opaque minerals (trace to 1 percent) in a pilotaxitic to intersertal groundmass of plagioclase, pyroxene, olivine(?), and glass. An exception is the elongate cinder cone in sec. 22, T. 8 N., R. 7 E., which is composed of augite-hypersthene andesite and may be a rift vent related to Capital Mountain volcanism

Basalt or andesite flows (Pleistocene)—Flows exposed in high west valley wall of Sheep and Boulder Creeks and on east side of Boulder Creek near north edge of quadrangle. Flows may be from two large cinder cones (Qbc) in sec. 15, T. 7 N., R. 6 E., and sec. 13, T. 8 N., R. 6 E. Rocks are porphyritic and contain phenocrysts of calcic plagioclase (trace to 10 percent, 1–3 mm) and olivine (trace to 5 percent, 0.2–2 mm) and sparse crystals of hypersthene in a pilotaxitic groundmass. Contact shown between underlying undifferentiated fine-grained andesite flows (Qfu) is mostly conjectural

Qob **Dikes (Pleistocene)**—Chiefly dark-colored andesitic or basaltic dikes probably mostly related to the north Sanford eruptive center. Known olivine basalt dikes labeled "ob." Not all dikes shown on map have been visited on ground. The name north Sanford eruptive center, as used here and throughout the "Description of Map Units," informally refers to an area of dikes, small plutons, domes, and vent deposits on the north flank of Mount Sanford, a large volcanic structure whose summit is 4 km south of the quadrangle in the contiguous Gulkana A–1 quadrangle

Intrusive andesite (Pleistocene)—Light- to medium-gray, porphyritic rock containing phenocrysts of plagioclase (4 percent, 1–3 mm in clots), augite (2 percent, 0.4 mm), and hypersthene (1 percent, 0.4 mm) rimmed by clinopyroxene, in an intergranular to felty goundmass of plagioclase, pyroxene, and opaque minerals. Forms a small massive pluton related to north Sanford eruptive center

Olivine basalt and basaltic andesite "ribbon flows" (Pleistocene)—Very thin to medium (<1 m–3 m) flows exhibiting conspicuous reddish-brown scoriaceous tops and bottoms that were erupted from rift vents on the flank of the north Sanford eruptive center. Rock is medium- to dark-gray, sparsely porphyritic lava containing phenocrysts of calcic plagioclase (2–5 percent, 2–4 mm) and olivine (1–5 percent, 0.5–2 mm) in an intersertal to locally intergranular or pilotaxitic groundmass of plagioclase, pyroxene, opaque minerals, and glass. Some flows southeast of Drop Glacier contain as much as a few percent phenocrystic hypersthene. Flows west of Drop Glacier were erupted from a linear zone at least 1 km long in sec. 4, T. 6 N., R. 7 E. (probably extends southwest into sec. 9) that is marked by an olivine basalt dike, scattered patches of olivine basalt pumice and cinder, and copper-stained fractures in the flows. Flows southeast of Drop Glacier apparently were erupted from a rift zone now occupied by a dike in secs. 25 and 26, T. 6 N., R. 7 E. Major-element chemistry for samples BCM–7 and BCM–8 (map localities 1 and 2) is shown in table 1. A potassium-argon date on flows from unit southeast of Drop Glacier in contiguous Nabesna B–6 quadrangle yielded age of 0.32±0.09 Ma (M. A. Lanphere and G. B. Dalrymple, unpub. data, 1973). Aggregate maximum thickness approximately 300 m

Rhyodacite flow (Pleistocene)—Massive, possibly single flow, about 20 km long, 10 km wide, and as much as 360 m thick occurs chiefly in the contiguous Nabesna B–6 quadrangle. Crystalline rock is light to medium-light gray and porphyritic containing phenocrysts of sodic plagioclase (4–7 percent, 2–5 mm), green clinopyroxene (trace to 2 percent, as much as 2 mm), and zero to traces of potassium feldspar and hornblende in a groundmass of microcrystalline to cryptocrystalline felty aggregates dusted with opaque minerals. Dark-gray to brownish-black massive vitrophyre occurs at top and base of flow. Flow apparently erupted from a vent in secs. 15 and 16, T. 6 N., R. 7 E. along the west side of north Sanford eruptive center; vent is marked by a massive rhyodacite dome(?) (stippled) that contains lenses and bands of phenocryst-rich pyroxene andesite(?) and which is cut by a series of northeast-trending olivine basalt dikes. In the Nabesna B–6 quadrangle, chemical analyses and potassium-argon dates indicate a composition of 69–70 percent SiO_2 (D. H. Richter and J. G. Smith, unpub. data, 1981) and an age of 0.53±0.06 Ma (M. A. Lanphere and G. B. Dalrymple, unpub. data, 1973).

Porphyritic dacite flows

Porphyritic olivine dacite or andesite (Pleistocene)—Medium-thick, locally glassy, light- to dark-gray, conspicuously porphyritic rocks containing phenocrysts of plagioclase (1–6 percent, 0.5–4 mm), olivine (1–3 percent, 0.2–3 mm), clinopyroxene (0–2 percent, 0.2–3 mm), and hypersthene (0–1 percent, 0.5–1 mm) in a trachytic to intersertal groundmass. Source vent marked by dike and irregular accumulations of cinder, bombs, and palagonitic ash and lapilli in NE1/4 sec. 11, T. 6 N., R. 6 E.

Qdp **Porphyritic dacite (Pleistocene)**—Extensive single flow, as much as 210 m thick, which underlies less silicic(?) flows of unit Qpod.

Crystalline rock is medium to dark gray and coarsely porphyritic containing phenocrysts of andesine (2–5 percent, 1–5 mm), clinopyroxene (1–2 percent, 0.5–2 mm) locally having reaction rims, and traces of hypersthene and opaque minerals in a trachytic groundmass of aligned plagioclase microlites in a glassy to cryptocrystalline matrix. Base of flow characterized by dark-gray to black vitrophyre, as much as 60 m thick, that locally exhibits exceptionally well developed columnar joints. Upper, more crystal-rich part of flow is generally platy and locally ropy. Source probably from vents higher on flank of north Sanford eruptive center than vent for unit Qpod. Major-element chemistry for samples BCM–10 and BCM–11 (map localities 3 and 4) is shown in table 1

Fine-grained to porphyritic andesite and basaltic andesite flows, undifferentiated (Pleistocene)—Unit probably includes some of the older extrusive rocks from the north Sanford eruptive center but may also include flows from other sources. Chiefly medium-light-gray to dark-gray and brownish-gray, medium to thick flows, generally platy and locally vitrophyric containing occasional interlayered tephra lenses (t). Dominant are fine-grained equigranular to microporphyritic and locally sparsely porphyritic flows containing microphenocrysts and phenocrysts of plagioclase (trace to 15 percent) in a microtrachytic to pilotaxitic groundmass. Microphenocrysts of clinopyroxene, hypersthene, olivine, and opaque minerals may be sparingly (less than 2 percent) present and in widely varying proportions. Less common are coarsely porphyritic flows containing phenocrysts of plagioclase (10–30 percent, 3–5 mm), hypersthene (2–6 percent, 0.5–3 mm), and traces of clinopyroxene and olivine in an intergranular to intersertal groundmass consisting generally of fine (0.05–0.1 mm) plagioclase, pyroxene, opaque minerals, and locally glass. Porphyritic flows are exposed underlying fine-grained flows in sec. 30, T. 7 N., R. 7 E., and overlying fine-grained flows in secs. 14, 15, 16, T. 6 N., R. 7 E. Major-element chemistry for sample BCM–12 (map locality 5), a fine-grained basaltic andesite, is shown in table 1

Undifferentiated volcanic rocks—Chiefly exposed in inaccessible outcrops in cirques at heads of glaciers above about 7,000 ft in elevation. Apparently largely from north Sanford eruptive center

Flat-lying flows (Pleistocene)—Thin to thick (1–15 m) flows probably equivalent in part to units Qfu, Qpd, Qpod, and possibly Qob

Vent deposits (?) (Pleistocene)—Gray, steeply dipping, layered tephra

Scorta (Pleistocene)—Reddish-brown scoria, cinder, and breccia intruded by numerous dikes

Capital Mountain volcano—Andesitic shield volcano of Pleistocene age that may have covered an area as much as 200 km^2 and has a roughly circular summit caldera 4 km in diameter. The shield consists chiefly of lava flows that dip 3°–25° away from the summit caldera. The caldera, whose walls dip 55°–80° inward, is filled with massive, flat-lying flows. Talus, flow breccias, and pillow-lavas occur locally between the caldera wall and caldera-fill flows. A prominent plug, 100 m high, marks the general center of an area of post-caldera-fill activity and is the locus of a spectacular radial dike swarm. Shield and caldera lavas are chiefly hypersthene andesites, but shield lavas tend to be more diverse and range in composition from basalt to dacite (table 1, fig. 1). The basalt and andesite of Capital Mountain volcano appear to be lower in K_2O than compositionally equivalent flows from younger north Sanford eruptive center (fig. 1)

Rhyolite dikes and laccoliths (Pleistocene)—Crystalline rock is very light gray and sparsely porphyritic containing phenocrysts of sodic plagioclase (trace to 2 percent, as much as 4 mm), biotite (trace to 1 percent, as much as 4 mm), and locally traces of potassium feldspar, hornblende, clinopyroxene, and olivine (rounded) in a cryptocrystalline groundmass dusted with fine opaque minerals. Vitrophyre is medium gray to very dark gray and generally forms margins of dikes and tops and floors of laccoliths. Probably represent last activity of Capital Mountain volcano. Largest dike, averaging 4 m wide, extends discontinuously about 8 km from the laccolithic bodies on southeast flank of shield northwesterly across the central part of the volcano. Major-element chemistry for sample 73–ARh–105 (map locality 6) is shown in table 1. Potassium-argon date on plagioclase from same sample yielded age of 1.09±0.17 Ma (table 2)

Radial dike swarm (Pleistocene)—Chiefly dark-colored dikes of mafic to intermediate composition, generally less than 4 m thick and a few kilometers long, that radiate from a summit area containing many plugs, and intrude both shield and caldera lavas. Not all dikes are shown on geologic map

ba, basaltic andesite and andesite dikes. Probably constitute more than 90 percent of dike swarm but are not readily distinguishable in field. Basaltic andesite varieties are medium to dark gray and variably porphyritic containing phenocrysts (5–40 percent, 1–7 mm) of andesine to slightly more calcic plagioclase, less fresh olivine, and minor to rare clinopyroxene, opaque minerals, and hypersthene in an intergranular to intersertal, locally hyalopilitic, groundmass of plagioclase, olivine, pyroxene, opaque minerals, and sparse glass. Plagioclase and plagioclase-olivine glomerocrysts as much as 1 cm in diameter are common, and in a few dikes the larger plagioclase phenocrysts appear to be more sodic than smaller plagioclase phenocrysts or groundmass plagioclase. Andesite dikes tend to be less porphyritic containing smaller phenocrysts (2–20 percent, 1–5 mm in diameter) consisting chiefly of andesine and slightly more sodic plagioclase, less hypersthene, and sparse clinopyroxene and opaque minerals in an intersertal to hyalopilitic groundmass of plagioclase, pyroxene, opaque minerals, and glass. Glomerocrystic clots of plagioclase+hypersthene±clinopyroxene are common. Major-element chemistry for sample BCM–1 (map locality 7), a basaltic andesite dike, is shown in table 1.

a, coarsely porphyritic andesite dikes. Resemble porphyritic andesite plugs (unit Qcp) and consist of large, complexly zoned plagioclase phenocrysts (30–40 percent, as much as 1 cm) and smaller (1–5 mm) clinopyroxene and hypersthene, all variably intergrown, in an intersertal groundmass of plagioclase laths (1–2 mm), two pyroxenes, opaque minerals, and glass. Major-element chemistry for sample BCM–4 (map locality 8) is shown in table 1. Potassium-argon whole-rock date on same sample yielded age of 1.03±0.06 Ma (table 2).

d, dacite dikes. Light- to medium-gray, sparsely porphyritic containing phenocrysts of sodic plagioclase (3–4 percent, 3–5 mm), hornblende with black oxide rims (trace to 2 percent, 1 to 3 mm), minor opaque minerals, and locally traces of hypersthene and biotite in a cryptocrystalline to felty groundmass of feldspar and minor opaque minerals

Andesite plugs (Pleistocene)—Concentrated chiefly in an area 1.5 km in diameter near the center of the caldera. Two types are recognized: principal type, which forms a prominent 100 m high spire, is a gray, medium-grained (1–2 mm), subhedral, granular rock containing about 80 percent plagioclase, 15 percent hypersthene, a few percent opaque minerals, and locally some cryptocrystalline interstitial material. The other type (stippled) occurs in smaller plugs and is dark gray to dark brownish gray, diabasic in texture, and conta
complexly zoned andesine (25–30 perce
clinopyroxene (5 percent, 1 mm), and opaqu
up to 1 mm) in an intergranular groundmass
opaque minerals, and locally glass. Andesine
intergrown with each other and with the sm
opaque-mineral phenocrysts. A few plugs ha
main vent area. The largest, in sec. 27, T. 8 N
gray andesite composed of a felty aggregate
pyroxene, and opaque minerals

Caldera lavas (Pleistocene)—Flat-lying flow
have scoriaceous tops but no observable
interbeds. Flows are almost entirely gray, high
andesite containing phenocrysts of plag
0.5–5 mm), hypersthene (2–10 percent, 0.2–1
crystal of clinopyroxene and rounded olivine in
line material, locally glassy, containing scar
Crystal-rich varieties are almost equigranula
hypersthene and very minor interstitial glass. S
intense brecciation and hydrothermal alterati
dikes, plugs, and irregular small intrusive
chemistry for sample BCM–3 (map locality
Maximum thickness greater than 450 m

Shield lavas and pyroclastic deposits (Ple

Thin to thick (2–10 m) flows—Contains s
interbeds of palagonitic lapilli tuff and pyro
chiefly gray to dark-gray, porphyritic hypersth
hypersthene-augite andesite and basaltic
olivine andesite and basaltic andesite, and olh
basalt. Typical hypersthene andesite contains
(5–15 percent, 0.5–1 mm) and hypersthene
in an intersertal to pilotaxitic groundmass
pyroxene, opaque minerals, and cryptocrys
this unit are less porphyritic and tend to be
flows (Qcc). Major-element chemistry for sa
and BCM–6 (map localities 11, 12, and 13,
table 1. Potassium-argon whole-rock dates
BCM–6 (localities 12 and 13) yielded ages
1.02±0.08 Ma, respectively (table 2)

Massive dacite flow or flows—As much
probably erupted late in the shield-building s
gray, porphyritic, and locally glassy containing
(3–10 percent, 1–2 mm), augite (1 percent, 0
percent, 0.1–0.5 mm), and opaque min
microtrachytic to cryptocrystalline groundma
istry for sample BCM–9 (map locality 10)

Larger deposits of pyroclastic breccia—
unit Qcs. Breccia deposits are chiefly expl
consist of crudely layered beds of angular bl
diameter) of andesite in a brownish-gray,
matrix interlayered with sparse, short, rubbly,
some mudflow deposits

Basaltic scoria and tuff (Pleistocene and Pli
basaltic scoria containing abundant ribbon
overlain by about 5 m of indurated, yellow
basaltic lapilli tuff. Exposed in small area in secs
where unit is unconformably overlain by
Mountain volcano (unit Qcs)

Qtcf **Old andesite flows (Pleistocene and Pliocen**
dark-gray, fine-grained to sparsely porphyritic a
1–2 percent small (<1 mm) phenocrysts of pl
pilotaxitic groundmass. Exposed in northea
apparently older than deposits of Capital M

Contact—Known, approximate, and inferred, qu

Caldera wall, showing dip—Dotted where c
caldera collapse side

Area of alteration and brecciation—Intense hyd
extreme brecciation within Capital Mountain

Glacial boundaries—Generalized upper limits o
to the following lateral moraines

CL — **Cobb Lakes**—Youngest and lowest

BC — **Boulder Creek**

SC — **Sanford-Copper**—Oldest and highest

Attitude of bedding and flow layering
Inclined
Horizontal

Attitude of flow banding in rhyolite
Inclined
Vertical

Sample locality—Locality numbers correspond
and 2

Petrographic sample

Petrographic sample that was also chemical

**Petrographic sample that was also chemical
potassium-argon methods**

Copper-stained fracture

Table 1.—Chemical analyses of samples of Wrangell Lava from the Gulkana B–1 Quadrangle, Alaska

[Analyses by U.S. Geological Survey X-ray spectroscopy methods (with exception of sample 73–ARh–105), analysts, A. J. Bartel, K. C. Stewart, and J. E. Taggart, Jr., and rock analysis methods (FeO, H_2O^+, H_2O^-, CO_2), analysts H. G. Raiman, Georgia Mason, and C. L. Bone. Sample 73–ARh–105 analyzed by U.S. Geological Survey rapid rock method, analyst, P.L.D. Elmore]

Locality no.	1	2	3	4	5	6	7	8	9	10	11	12	13
Sample no.	BCM–7	BCM–8	BCM–10	BCM–11	BCM–12	73–ARh–105	BCM–1	BCM–4	BCM–3	BCM–9	BCM–2	BCM–5	BCM–6
Map unit	Qob	Qob	Qpd	Qpd	Qfu	Qcr	dike ba	dike a	Qcc	Qcad	Qcs	Qcs	Qcs
SiO_2	53.0	52.8	62.6	63.4	54.2	70.7	53.8	57.2	55.8	63.2	54.5	54.1	52.2
Al_2O_3	15.8	16.9	16.2	16.1	17.1	16.0	17.5	18.0	17.7	16.2	17.5	17.8	17.8
Fe_2O_3	2.21	2.89	1.48	1.28	2.39	0.80	3.94	1.84	4.00	2.60	2.83	2.25	1.90
FeO	7.09	5.65	4.19	4.01	6.84	1.0	4.23	4.00	3.29	2.27	2.57	5.19	6.47
MgO	4.88	5.84	1.68	1.48	4.01	0.52	4.03	4.30	4.37	1.46	5.21	5.33	6.27
CaO	7.54	8.43	4.02	3.84	7.39	1.5	7.40	7.71	7.29	3.50	8.25	8.32	8.89
Na_2O	3.83	3.89	4.92	5.18	3.97	4.5	3.92	3.67	3.72	5.05	3.29	3.55	3.68
K_2O	1.57	1.15	2.36	2.55	1.32	3.6	1.03	1.24	1.70	0.97	1.00	0.82	0.82
H_2O^+	0.50	0.13	0.34	0.27	0.28	0.53	0.99	0.60	0.23	0.84	0.80	0.82	0.15
H_2O^-	0.09	0.09	0.11	0.09	0.10	0.11	0.32	0.18	0.81	0.09	0.64	0.57	0.09
TiO_2	1.84	1.80	1.01	0.94	1.89	0.38	1.34	0.88	0.98	0.94	0.96	1.13	1.53
P_2O_5	0.86	0.82	0.32	0.30	0.45	0.08	0.35	0.23	0.30	0.33	0.23	0.30	0.36
MnO	0.18	0.13	0.14	0.14	0.18	0.10	0.14	0.10	0.11	0.12	0.11	0.12	0.14
CO_2	<0.01	<0.01	<0.01	<0.01	<0.01	<0.05	0.64	<0.01	0.02	<0.01	<0.01	0.02	<0.01
Total	99.59	99.51	99.36	99.37	100.01	99.80	99.83	99.72	99.84	99.30	99.86	100.01	100.18
SiO_2 (water-free normalized to 100)	53.5	53.2	63.3	64.0	54.4	71.0	54.4	57.9	56.5	64.2	55.5	54.7	52.2

Table 2.—K-Ar determinations and analytical data on volcanic rocks from the Gulkana B–1 quadrangle, Alaska

[Potassium analyses by P. R. Klock, S. T. Neil, and D. V. Vivit. Argon analyses by J. E. Conrad, L. B. G. Pickthorn, J. C. Von Essen, and J. G. Smith. Ages calculated using the following constants: λ_e=0.581×10^{-10} yr^{-1}, λ_{β}=4.962×10^{-10} yr^{-1}, and $^{40}K/K$=1.167×10^{-4} atom percent]

Sample locality number	Sample number	Sample locality: Latitude (North)	Sample locality: Longitude (West)	Material dated and treatment	K_2O (weight percent): First	K_2O (weight percent): Second	K_2O (weight percent): Third	K_2O (weight percent): Average	Radiogenic argon: moles argon ($x10^{-12}$)	% rad argon	Age (10^6 years)
6	73–ARh–105	62°24.1′	144°01.1′	Plag	0.487	0.487	---	0.487	0.7621	9.2	1.09±0.17
8	BCM–4	62°25.8′	144°07.4′	Wr, nt	1.168	1.172	---	1.169	1.737	8.9	1.03±0.06
12	BCM–5	62°28.4′	144°08.2′	Wr, nt	1.095	1.160	1.130	1.128	1.687	4.1	1.04±0.11
13	BCM–6	62°27.3′	144°08.0′	Wr, nt	1.008	1.004	---	1.006	1.480	8.8	1.02±0.08

[1]Wr=whole rock, nt=not treated. Plag=plagioclase.

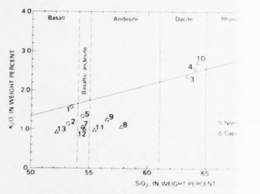


**Figure 1.—K_2O-SiO_2 variation diagram of Wrangell Lava s
B–1 quadrangle, Alaska, showing arbitrary rock nomen
and high-K—medium-K discriminat line after Peccerill
Ewart (1979). Numbers refer to samples in table 1**

GEOLOGIC MAP OF THE GULKANA B–1 QUADRANGLE, SOUTH-CENTRAL ALASKA

By

D. H. Richter, J. C. Ratté, H. R. Schmoll, W. P. Leeman,
J. G. Smith, and L. A. Yehle

1989

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GULKANA B–1 QUADR

REFERENCES CITED

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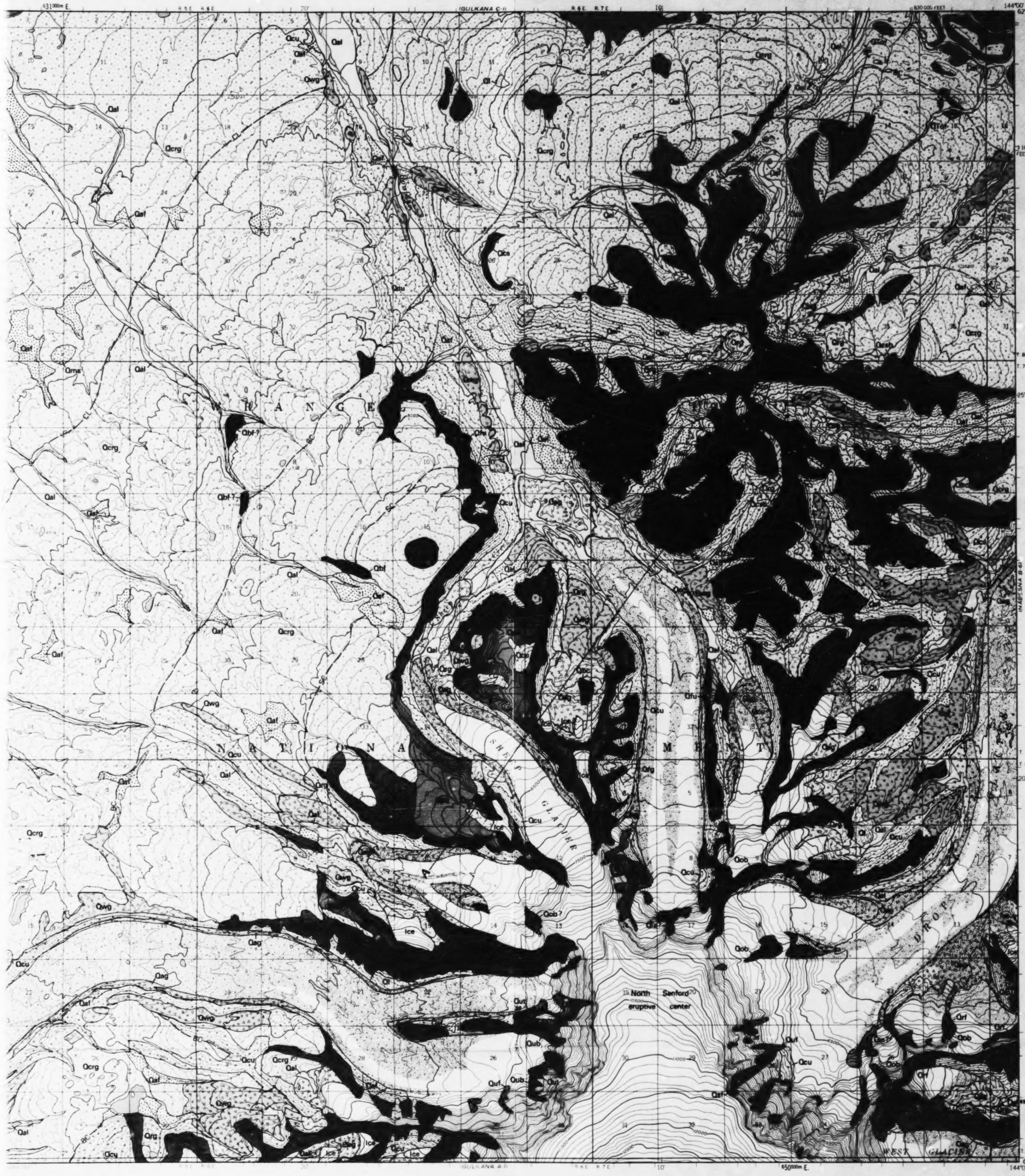
...OGICAL SURVEY

GEOLOGIC QUADRANGLE MAP
GULKANA B–1 QUADRANGLE, ALASKA
GQ–1655



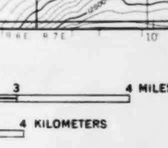
...al Survey, 1959
...n Alaska coordinate system, zone 3
...ansverse Mercator grid ticks, zone 6, shown in blue

SCALE 1:63 360

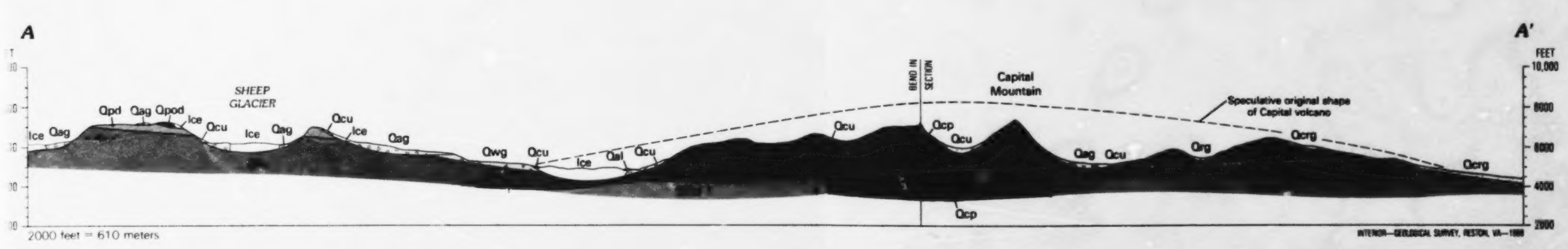
1 ½ 0 1 2 3 4 MILES

1 .5 0 1 2 3 4 KILOMETERS

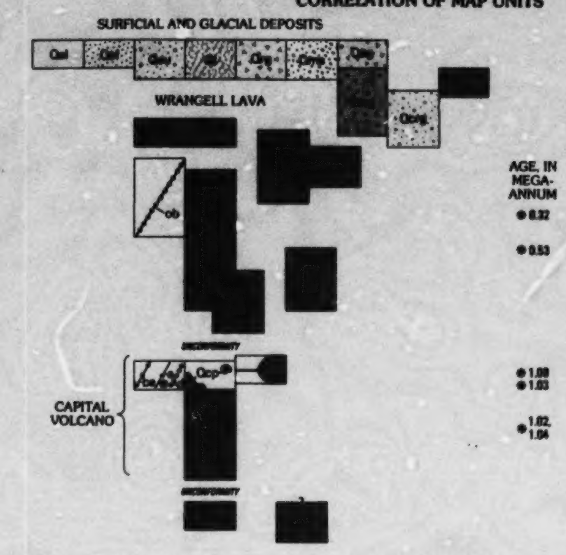
CONTOUR INTERVAL 100 FEET
NATIONAL GEODETIC VERTICAL DATUM OF 1929



Bedrock geology by D. H. Richter, 1981–82, J. G. Smith, 1981, and J. C. Ratté and W. P. Leeman, 1982, in 8 helicopter-supported days. Glacial and surficial geology by H. R. Schmoll and L. A. Yehle chiefly by air photo interpretation supported by 2 days of helicopter field checking in 1983



CORRELATION OF MAP UNITS



DESCRIPTION OF MAP UNITS

Alluvial deposits (Holocene)

Qal **Alluvium in streams**—Mainly in active flood plains and terraces of major streams and some minor streams. Includes outwash in channels and aprons related to older phase of the Alaskan glaciation. Chiefly sand and gravel, local cobbles and boulders

Qaf **Alluvium in fans**—Includes large broad fans in low-lying areas and some fans and cones on steep mountain slopes mainly along major streams. Also includes some fans, containing mostly fine-grained material, along minor streams on gentle slopes of Mount Sanford. Chiefly sand, gravel, and boulders

Colluvial deposits (Holocene and Pleistocene)

Qcu **Colluvium, undifferentiated**—Chiefly talus but includes deposits of small landslides, rock glaciers, and other mass-wastage processes, generally includes alluvium in numerous small fans and cones. May also include remnants of valley-glacier moraines. Occurs mainly on steep valley walls in bedrock. Chiefly unsorted silt, sand, gravel, and boulders

Ql **Landslide deposits**—Includes large slump and block-glide deposits and some large debris avalanches in both bedrock and glacial deposits

Qrg **Rock-glacier deposits (Holocene and Pleistocene)**—Includes deposits in active rock glaciers, which have well-defined lobate and tongue-shaped forms, small coalescing rock glaciers, which form linear ridges along bases of steep slopes, and inactive rock glaciers, which have smooth forms. Chiefly angular blocks and diamicton

Qms **Mineral-spring(?) deposits (Holocene and Pleistocene)**—Deposits in two conical landforms that may have originated by reworking of glacial deposits through mineral-spring activity; only more northerly of landforms contains a summit lake. Deposits may be similar to those in larger and better formed cones several kilometers southwest (Nichols and Yehle, 1961)

Valley-glacier deposits

Qag **Drift of Alaskan glaciation (Holocene)**—Includes end and lateral moraines of the younger (Tunnel) phase of Alaskan glaciation, deposited after recession of existing glaciers, and end moraines of older (Tustamena?) phase of Alaskan glaciation. Diamicton and rubble, local gravel

Qwg **Drift of Wisconsin glaciation (Pleistocene)**—End, lateral, and ground moraines and local outwash of younger and older phases of Drop Creek moraines (Schmoll, 1984). Locally modified by mass slumping and other colluvial and alluvial processes. Diamicton and boulders, local gravel and sand

Qcrg **Copper River basin glacier deposits (Pleistocene)**—Includes Cobb Lakes, Boulder Creek, and Sanford-Copper lateral moraines (Schmoll, 1984), the boundaries of which are shown by line symbol. Also includes ground-moraine, esker, kame, channel, valley-fill, and outwash deposits related to these moraines as well as older ground moraine. Occurs mainly on broad slopes of Mount Sanford and Capital Mountain. Deposits locally extensively modified by colluvial processes, including downslope movement, debris flow, solifluction, and creep, and by stream action. Chiefly diamicton and rubble, local sand and gravel

Glaciolacustrine deposits (Pleistocene)—Deposits on floor and sloping shore areas of glacial Lake Atna. Chiefly interbedded clay, silt, and fine sand, locally pebbly. Exposed only in extreme northwest corner of quadrangle, below elevation of 2,500 ft

Wrangell Lava

Olivine andesite flow (Pleistocene)—Medium-gray, sparsely porphyritic lava containing small (0.5 mm) phenocrysts of olivine in a trachytic groundmass of plagioclase, hypersthene, and opaque minerals. Thick (100 m) single flow, exhibiting intricately contorted columnar joints, that may have flowed down valley beneath ice. Exposed only in secs. 1 and 2, T. 6 N., R. 7 E.

Young Sanford flows (Pleistocene)—Exposed only high in the cirque wall at the head of Drop Glacier. Flows appear to drape over older flat-lying flows (unit Quf) and are probably young lavas from the main cone of Mount Sanford volcano, whose summit is about 6 km south in Gulkana A–1 quadrangle

Olivine basalt cinder cones (Pleistocene)—Small cinder cones, some with small-volume vesicular and scoriaceous flows, appear to be restricted to zone encircling Capital Mountain volcano. Cones consist of reddish-brown cinder, bombs, and irregular masses of spatter; a few still exhibit their original topographic form. Nonoxidized rocks are dark-gray, porphyritic and microporphyritic lava containing phenocrysts of calcic plagioclase (1–20 percent, 0.4–1.5 mm), olivine (1–10 percent, 0.2–1 mm), and opaque minerals (trace to 1 percent) in a pilotaxitic to intersertal groundmass of plagioclase, pyroxene, olivine(?), and glass. An exception is the elongate cinder cone in sec. 22, T. 8 N., R. 7 E., which is composed of augite-hypersthene andesite and may be a rift vent related to Capital Mountain volcanism

Basalt or andesite flows (Pleistocene)—Flows exposed in high west valley wall of Sheep and Boulder Creeks and on east side of Boulder Creek near north edge of quadrangle. Flows may be from two large cinder cones (Qbc) in sec. 15, T. 7 N., R. 6 E., and sec. 13, T. 8 N., R. 6 E. Rocks are porphyritic and contain phenocrysts of calcic plagioclase (trace to 10 percent, 1–3 mm) and olivine (trace to 5 percent, 0.2–2 mm) and sparse crystals of hypersthene in a pilotaxitic groundmass. Contact shown between underlying undifferentiated fine-grained andesite flows (Qfu) is mostly conjectural

ob **Dikes (Pleistocene)**—Chiefly dark-colored andesitic or basaltic dikes probably mostly related to the north Sanford eruptive center. Known olivine basalt dikes labeled "ob." Not all dikes shown on map have been visited on ground. The name north Sanford eruptive center, as used here and throughout the "Description of Map Units," informally refers to an area of dikes, small plutons, domes, and vent deposits on the north flank of Mount Sanford, a large volcanic structure whose summit is 4 km south of the quadrangle in the contiguous Gulkana A–1 quadrangle

Intrusive andesite (Pleistocene)—Light- to medium-gray, porphyritic rock containing phenocrysts of plagioclase (4 percent, 1–3 mm in clots), augite (2 percent, 0.4 mm), and hypersthene (1 percent, 0.4 mm) rimmed by clinopyroxene, in an intergranular to felty groundmass of plagioclase, pyroxene, and opaque minerals. Forms a small massive pluton related to north Sanford eruptive center

Olivine basalt and basaltic andesite "ribbon flows" (Pleistocene)—Very thin to medium (<1 m–3 m) flows exhibiting conspicuous reddish-brown scoriaceous tops and bottoms that were erupted from rift vents on the flank of the north Sanford eruptive center. Rock is medium- to dark-gray, sparsely porphyritic lava containing phenocrysts of calcic plagioclase (2–5 percent, 2–4 mm) and olivine (1–5 percent, 0.5–2 mm) in an intersertal to locally intergranular or pilotaxitic groundmass of plagioclase, pyroxene, opaque minerals, and glass. Some flows southeast of Drop Glacier contain as much as a few percent phenocrystic hypersthene. Flows west of Drop Glacier were erupted from a linear zone at least 1 km long in sec. 4, T. 6 N., R. 7 E. (probably extends southwest into sec. 9) that is marked by an olivine basalt dike, scattered patches of olivine basalt pumice and cinder, and copper-stained fractures in the flows. Flows southeast of Drop Glacier apparently were erupted from a rift zone now occupied by a dike in secs. 25 and 26, T. 6 N., R. 7 E. Major-element chemistry for samples BCM–7 and BCM–8 (map localities 1 and 2) is shown in table 1. A potassium-argon date on flows from unit southeast of Drop Glacier in contiguous Nabesna B–6 quadrangle yielded age of 0.32±0.09 Ma (M. A. Lanphere and G. B. Dalrymple, unpub. data, 1973). Aggregate maximum thickness approximately 300 m

Rhyodacite flow (Pleistocene)—Massive, possibly single flow, about 20 km long, 10 km wide, and as much as 360 m thick occurs chiefly in the contiguous Nabesna B–6 quadrangle. Crystalline rock is light to medium-light gray and porphyritic containing phenocrysts of sodic plagioclase (4–7 percent, 2–5 mm), green clinopyroxene (trace to 2 percent, as much as 2 mm), and zero to traces of potassium feldspar and hornblende in a groundmass of microcrystalline to cryptocrystalline felty aggregates dusted with opaque minerals. Dark-gray to brownish-black massive vitrophyre occurs at top and base of flow. Flow apparently erupted from a vent in secs. 15 and 16, T. 6 N., R. 7 E. along the west side of north Sanford eruptive center; vent is marked by a massive rhyodacite dome(?) (stippled) that contains lenses and bands of phenocryst-rich pyroxene andesite(?) and which is cut by a series of northeast-trending olivine basalt dikes. In the Nabesna B–6 quadrangle, chemical analyses and potassium-argon dates indicate a composition of 69–70 percent SiO_2 (D. H. Richter and J. G. Smith, unpub. data, 1981) and an age of 0.53±0.06 Ma (M. A. Lanphere and G. B. Dalrymple, unpub. data, 1973)

Porphyritic dacite flows

Porphyritic olivine dacite or andesite (Pleistocene)—Medium-thick, locally glassy, light- to dark-gray, conspicuously porphyritic rocks containing phenocrysts of plagioclase (1–6 percent, 0.5–4 mm), olivine (1–3 percent, 0.2–3 mm), clinopyroxene (0–2 percent, 0.2–3 mm), and hypersthene (0–1 percent, 0.5–1 mm) in a trachytic to intersertal groundmass. Source vent marked by dike and irregular accumulations of cinder, bombs, and palagonitic ash and lapilli in NE1/4 sec. 11, T. 6 N., R. 6 E.

Porphyritic dacite (Pleistocene)—Extensive single flow, as much as 210 m thick, which underlies less silicic(?) flows of unit Qpod. Crystalline rock is medium to dark gray and coarsely porphyritic containing phenocrysts of andesine (2–5 percent, 1–5 mm), clinopyroxene (1–2 percent, 0.5–2 mm) locally having reaction rims, and traces of hypersthene and opaque minerals in a trachytic groundmass of aligned plagioclase microlites in a glassy to cryptocrystalline matrix. Base of flow characterized by dark-gray to black vitrophyre, as much as 60 m thick, that locally exhibits exceptionally well developed columnar joints. Upper, more crystal-rich part of flow is generally platy and locally ramped. Source probably from vents higher on flank of north Sanford eruptive center than vent for unit Qpod. Major-element chemistry for samples BCM–10 and BCM–11 (map localities 3 and 4) is shown in table 1

Fine-grained to porphyritic andesite and basaltic andesite flows, undifferentiated (Pleistocene)—Unit probably includes some of the older extrusive rocks from the north Sanford eruptive center but may also include flows from other sources. Chiefly medium-light-gray to dark-gray and brownish-gray, medium to thick flows, generally platy and locally vitrophyric containing occasional interlayered tephra lenses (t). Dominant are fine-grained equigranular to microporphyritic and locally sparsely porphyritic flows containing microphenocrysts and phenocrysts of plagioclase (trace to 15 percent) in a microtrachytic to pilotaxitic groundmass. Microphenocrysts of clinopyroxene, hypersthene, olivine, and opaque minerals may be sparingly (less than 2 percent) present and in widely varying proportions. Less common are coarsely porphyritic flows containing phenocrysts of plagioclase (10–30 percent, 3–5 mm), hypersthene (2–6 percent, 0.5–3 mm), and traces of clinopyroxene and olivine in an intergranular to intersertal groundmass consisting generally of fine (0.05–0.1 mm) plagioclase, pyroxene, opaque minerals, and locally glass. Porphyritic flows are exposed underlying fine-grained flows in sec. 30, T. 7 N., R. 7 E., and overlying fine-grained flows in secs. 14, 15, 16, T. 6 N., R. 7 E. Major-element chemistry for sample BCM–12 (map locality 5), a fine-grained basaltic andesite, is shown in table 1

Undifferentiated volcanic rocks—Chiefly exposed in inaccessible outcrops in cirques at heads of glaciers above about 7,000 ft in elevation. Apparently largely from north Sanford eruptive center

Flat-lying flows (Pleistocene)—Thin to thick (1–15 m) flows probably equivalent in part to units Qfu, Qpd, Qpod, and possibly Qob

Vent deposits (?) (Pleistocene)—Gray, steeply dipping, layered tephra

Scoria (Pleistocene)—Reddish-brown scoria, cinder, and breccia intruded by numerous dikes

Capital Mountain volcano—Andesitic shield volcano of Pleistocene age that may have covered an area as much as 200 km² and has a roughly circular summit caldera 4 km in diameter. The shield consists chiefly of lava flows that dip 3°–25° away from the summit caldera. The caldera, whose walls dip 55°–80° inward, is filled with massive, flat-lying flows. Talus, flow breccias, and pillow-lavas occur locally between the caldera wall and caldera-fill flows. A prominent plug, 100 m high, marks the general center of an area of post-caldera-fill activity and is the locus of a spectacular radial dike swarm. Shield and caldera lavas are chiefly hypersthene andesites, but shield lavas tend to be more diverse and range in composition from basalt to dacite (table 1, fig. 1). The basalt and andesite of Capital Mountain volcano appear to be lower in K_2O than compositionally equivalent flows from younger north Sanford eruptive center (fig. 1)

Rhyolite dikes and laccoliths (Pleistocene)—Crystalline rock is very light gray and sparsely porphyritic containing phenocrysts of sodic plagioclase (trace to 2 percent, as much as 4 mm), biotite (trace to 1 percent, as much as 4 mm), and locally traces of potassium feldspar, hornblende, clinopyroxene, and olivine (rounded) in a cryptocrystalline groundmass dusted with fine opaque minerals. Vitrophyre is medium gray to very dark gray and generally forms margins of dikes and tops and floors of laccoliths. Probably represent last activity of Capital Mountain volcano. Largest dike, averaging 4 m wide, extends discontinuously about 8 km from the laccolithic bodies on southeast flank of shield northwesterly across the central part of the volcano. Major-element chemistry for sample 73–ARh–105 (map locality 6) is shown in table 1. Potassium-argon date on plagioclase from same sample yielded age of 1.09±0.17 Ma (table 2)

Radial dike swarm (Pleistocene)—Chiefly dark-colored dikes of mafic to intermediate composition, generally less than 4 m thick and a few kilometers long, that radiate from a summit area containing many plugs, and intrude both shield and caldera lavas. Not all dikes are shown on geologic map.

ba, basaltic andesite and andesite dikes. Probably constitute more than 90 percent of dike swarm but are not readily distinguishable in field. Basaltic andesite varieties are medium to dark gray and variably porphyritic containing phenocrysts (5–40 percent, 1–7 mm) of andesine to slightly more calcic plagioclase, less fresh olivine, and minor to rare clinopyroxene, opaque minerals, and hypersthene in an intergranular to intersertal, locally hyalopilitic, groundmass of plagioclase, olivine, pyroxene, opaque minerals, and sparse glass. Plagioclase and plagioclase-olivine glomerocrysts as much as 1 cm in diameter are common, and in a few dikes the larger plagioclase phenocrysts appear to be more sodic than smaller plagioclase phenocrysts or groundmass plagioclase. Andesite dikes tend to be less porphyritic containing smaller phenocrysts (2–20 percent, 1–5 mm in diameter) consisting chiefly of andesine and slightly more sodic plagioclase, less hypersthene, and sparse clinopyroxene and opaque minerals in an intersertal to hyalopilitic groundmass of plagioclase, pyroxene, opaque minerals, and glass. Glomerocrystic clots of plagioclase+hypersthene±clinopyroxene are common. Major-element chemistry for sample BCM–1 (map locality 7), a basaltic andesite dike, is shown in table 1.

a, coarsely porphyritic andesite dikes. Resemble porphyritic andesite plugs (unit Qcp) and consist of large, complexly zoned plagioclase phenocrysts (30–40 percent, as much as 1 cm) and smaller (1–5 mm) clinopyroxene and hypersthene, all variably intergrown, in an intersertal groundmass of plagioclase laths (1–2 mm), two pyroxenes, opaque minerals, and glass. Major-element chemistry for sample BCM–4 (map locality 8) is shown in table 1. Potassium-argon whole-rock date on same sample yielded age of 1.03±0.06 Ma (table 2).

d, dacite dikes. Light- to medium-gray, sparsely porphyritic containing phenocrysts of sodic plagioclase (3–4 percent, 3–5 mm), hornblende with black oxide rims (trace to 2 percent, 1 to 3 mm), minor opaque minerals, and locally traces of hypersthene and biotite in a cryptocrystalline to felty groundmass of feldspar and minor opaque minerals

Qcp **Andesite plugs (Pleistocene)**—Concentrated chiefly in an area 1.5 km in diameter near the center of the caldera. Two types are recognized: principal type, which forms a prominent 100 m high spire, is a gray, medium-grained (1–2 mm), subhedral, granular rock containing about 80 percent plagioclase, 15 percent hypersthene, a few percent opaque minerals, and locally some cryptocrystalline interstitial material. The other type (stippled) occurs in smaller plugs and is dark gray to dark brownish gray, diabasic in texture, and contains phenocrysts of large, complexly zoned andesine (25–30 percent, as much as 2 cm), clinopyroxene (5 percent, 1 mm), and opaque minerals (2–4 percent, up to 1 mm) in an intergranular groundmass of plagioclase, pyroxene, opaque minerals, and locally glass. Andesine phenocrysts are typically intergrown with each other and with the smaller clinopyroxene and opaque-mineral phenocrysts. A few plugs have been mapped outside main vent area. The largest, in sec. 27, T. 8 N., R. 7 E., is massive, light-gray andesite composed of a felty aggregate of plagioclase (0.2 mm), pyroxene, and opaque minerals

Caldera lavas (Pleistocene)—Flat-lying flows 10–90 m thick generally have scoriaceous tops but no observable pyroclastic or epiclastic interbeds. Flows are almost entirely gray, highly porphyritic hypersthene andesite containing phenocrysts of plagioclase (5–50 percent, 0.5–5 mm), hypersthene (2–10 percent, 0.2–1.5 mm), and an occasional crystal of clinopyroxene and rounded olivine in a matrix of cryptocrystalline material, locally glassy, containing scattered opaque minerals. Crystal-rich varieties are almost equigranular and contain subophitic hypersthene and very minor interstitial glass. Stippling indicates area of intense brecciation and hydrothermal alteration containing numerous dikes, plugs, and irregular small intrusive bodies. Major-element chemistry for sample BCM–3 (map locality 9) is shown in table 1. Maximum thickness greater than 450 m

Shield lavas and pyroclastic deposits (Pleistocene)

Thin to thick (2–10 m) flows—Contains sparse thin (less than 2 m) interbeds of palagonitic lapilli tuff and pyroclastic breccia. Flows are chiefly gray to dark-gray, porphyritic hypersthene andesite but include hypersthene-augite andesite and basaltic andesite, hypersthene-olivine andesite and basaltic andesite, and olivine basaltic andesite and basalt. Typical hypersthene andesite contains phenocrysts of plagioclase (5–15 percent, 0.5–1 mm) and hypersthene (1–5 percent, 0.1–1 mm) in an intersertal to pilotaxitic groundmass of plagioclase microlites, pyroxene, opaque minerals, and cryptocrystalline material. Flows of this unit are less porphyritic and tend to be more mafic than caldera flows (Qcc). Major-element chemistry for samples BCM–2, BCM–5, and BCM–6 (map localities 11, 12, and 13, respectively) is shown in table 1. Potassium-argon whole-rock dates on samples BCM–5 and BCM–6 (localities 12 and 13) yielded ages of 1.04±0.11 Ma and 1.02±0.08 Ma, respectively (table 2)

Massive dacite flow or flows—As much as 100 m thick, which probably erupted late in the shield-building sequence. Rock is medium gray, porphyritic, and locally glassy containing phenocrysts of plagioclase (3–10 percent, 1–2 mm), augite (1 percent, 0.5 mm), hypersthene (1–2 percent, 0.1–0.5 mm), and opaque minerals (1 percent) in a microtrachytic to cryptocrystalline groundmass. Major-element chemistry for sample BCM–9 (map locality 10) is shown in table 1

Larger deposits of pyroclastic breccia—Mapped separately from unit Qcs. Breccia deposits are chiefly explosive vent deposits and consist of crudely layered beds of angular blocks (as much as 1 m in diameter) of andesite in a brownish-gray, fine-grained tuffaceous matrix interlayered with sparse, short, rubbly flows. Unit may include some mudflow deposits

Basaltic scoria and tuff (Pleistocene and Pliocene)—Reddish-brown basaltic scoria containing abundant ribbon and breadcrust bombs overlain by about 5 m of indurated, yellowish-brown, palagonitic, basaltic lapilli tuff. Exposed in small area in secs. 16 and 21, T. 7 N., R. 7 E. where unit is unconformably overlain by shield lavas of Capital Mountain volcano (unit Qcs)

Old andesite flows (Pleistocene and Pliocene)—Chiefly medium- to dark-gray, fine-grained to sparsely porphyritic augite andesite containing 1–2 percent small (<1 mm) phenocrysts of plagioclase and augite in a pilotaxitic groundmass. Exposed in northeast corner of quadrangle; apparently older than deposits of Capital Mountain volcano

Contact—Known, approximate, and inferred; queried where uncertain

Caldera wall, showing dip—Dotted where concealed. Hachures on caldera collapse side

Area of alteration and brecciation—Intense hydrothermal alteration and extreme brecciation within Capital Mountain caldera

Glacial boundaries—Generalized upper limits of glacial deposits related to the following lateral moraines

— CL — **Cobb Lakes**—Youngest and lowest

— BC — **Boulder Creek**

— SC — **Sanford-Copper**—Oldest and highest

Attitude of bedding and flow layering

Inclined

Horizontal

Attitude of flow banding in rhyolite

Inclined

Vertical

Sample locality—Locality numbers correspond to numbers in tables 1 and 2

• **Petrographic sample**

×5 **Petrographic sample that was also chemically analyzed**

•8 **Petrographic sample that was also chemically analyzed and dated by potassium-argon methods**

\+ **Copper-stained fracture**

Table 1.—*Chemical analyses of samples of Wrangell Lava from the Gulkana B–1 Quadrangle, Alaska*

[Analyses by U.S. Geological Survey X-ray spectroscopy methods (with exception of sample 73–ARh–105), analysts, A. J. Bartel, K. C. Stewart, and J. E. Taggart, Jr., and rock analysis methods (FeO, H_2O^+, H_2O^-, CO_2), analysts H. G. Neiman, Georgia Mason, and C. L. Stone. Sample 73–ARh–105 analyzed by U.S. Geological Survey rapid rock method, analyst, P.L.D. Elmore]

Locality no.	1	2	3	4	5	6	7	8	9	10	11	12	13
Sample no.	BCM–7	BCM–8	BCM–10	BCM–11	BCM–12	73–ARh–105	BCM–1	BCM–4	BCM–3	BCM–9	BCM–2	BCM–5	BCM–6
Map unit	Qob	Qob	Qpd	Qpd	Qfu	Qcr	dike ba	dike a	Qcc	Qcsd	Qcs	Qcs	Qcs
SiO_2	53.0	52.8	62.6	63.4	54.2	70.7	53.6	57.2	55.8	63.2	54.5	54.1	52.2
Al_2O_3	16.6	16.9	16.2	16.1	17.1	16.0	17.9	18.0	17.7	16.2	17.9	17.6	17.8
Fe_2O_3	2.21	2.59	1.48	1.28	2.39	0.80	3.84	1.84	4.00	2.60	3.83	2.25	1.90
FeO	7.08	5.65	4.19	4.01	6.64	1.0	4.23	4.00	3.29	2.27	2.97	5.19	6.47
MgO	4.89	5.94	1.08	1.48	4.01	0.52	4.03	4.30	4.37	1.46	5.21	5.33	6.27
CaO	7.64	8.43	4.02	3.64	7.39	1.5	7.40	7.71	7.29	3.50	8.25	8.32	8.89
Na_2O	3.83	3.68	4.92	5.18	3.97	4.5	3.92	3.67	3.72	5.05	3.29	3.85	3.66
K_2O	1.57	1.15	2.35	2.55	1.32	3.8	1.03	1.03	1.24	2.70	0.97	1.00	0.92
H_2O^+	0.50	0.13	0.34	0.27	0.28	0.53	0.99	0.80	0.23	0.84	0.80	0.62	0.15
H_2O^-	0.09	0.09	0.11	0.08	0.10	0.11	0.32	0.18	0.81	0.09	0.64	0.57	0.09
TiO_2	1.94	1.50	1.01	0.94	1.89	0.30	1.34	0.66	0.96	0.94	0.96	1.13	1.53
P_2O_5	0.88	0.52	0.32	0.30	0.45	0.08	0.35	0.23	0.30	0.33	0.23	0.30	0.38
MnO	0.16	0.13	0.14	0.14	0.16	0.10	0.14	0.10	0.11	0.12	0.11	0.12	0.14
CO_2	<0.01	<0.01	<0.01	<0.01	<0.01	<0.05	0.64	<0.01	0.02	<0.01	<0.01	0.02	<0.01
Total	99.59	99.51	99.36	99.37	100.01	99.80	99.83	99.72	99.84	99.30	99.66	100.01	100.18
SiO_2 (water-free normalized to 100)	53.5	53.2	63.3	64.0	54.4	71.0	54.4	57.8	56.5	64.2	55.5	54.7	52.2

Table 2.—*K-Ar determinations and analytical data on volcanic rocks from the Gulkana B–1 quadrangle, Alaska*

[Potassium analyses by P. R. Klock, S. T. Neil, and D. V. Vivit. Argon analyses by J. E. Conrad, L.B.G. Pickthorn, J. C. Von Essen, and J. G. Smith. Ages calculated using the following constants: λ_ε=0.581x10^{-10}yr^{-1}, λ_β=4.962x10^{-10} yr^{-1}, and ^{40}K/K=1.167x10^{-4} atom percent]

Sample locality number	Sample number	Sample locality: Latitude (North)	Sample locality: Longitude (West)	Material dated and treatment[1]	K_2O (weight percent): First	Second	Third	Average	Radiogenic argon, moles/gram (x10^{-12})	% rad argon	Age (10^6 years)
6	73–ARh–105	62°24.1'	144°01.1'	Plag	0.487	0.487	---	0.487	0.7621	9.2	1.09±0.17
8	BCM–4	62°25.8'	144°07.4'	Wr, nit	1.165	1.172	---	1.169	1.737	8.9	1.03±0.06
12	BCM–5	62°26.4'	144°08.3'	Wr, nit	1.095	1.160	1.130	1.128	1.687	4.1	1.04±0.11
13	BCM–6	62°27.3'	144°08.0'	Wr, nit	1.008	1.004	---	1.006	1.480	8.8	1.02±0.08

[1] Wr=whole rock, nit=nitric acid treated, Plag=plagioclase.

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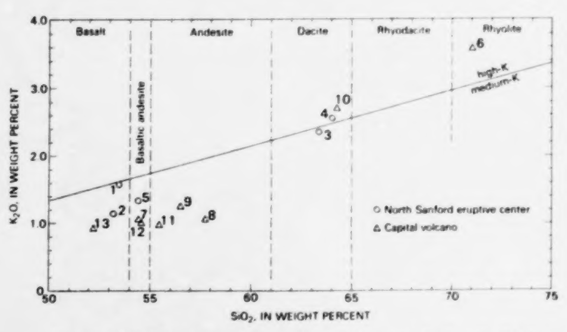

Figure 1.—K_2O-SiO_2 variation diagram of Wrangell Lava samples from the Gulkana B–1 quadrangle, Alaska, showing arbitrary rock nomenclature used in this report and high-K—medium-K discriminant line after Peccerillo and Taylor (1976) and Ewart (1979). Numbers refer to samples in table 1.

GEOLOGIC MAP OF THE GULKANA B–1 QUADRANGLE, SOUTH-CENTRAL ALASKA

By
D. H. Richter, J. C. Ratté, H. R. Schmoll, W. P. Leeman,
J. G. Smith, and L. A. Yehle
1989

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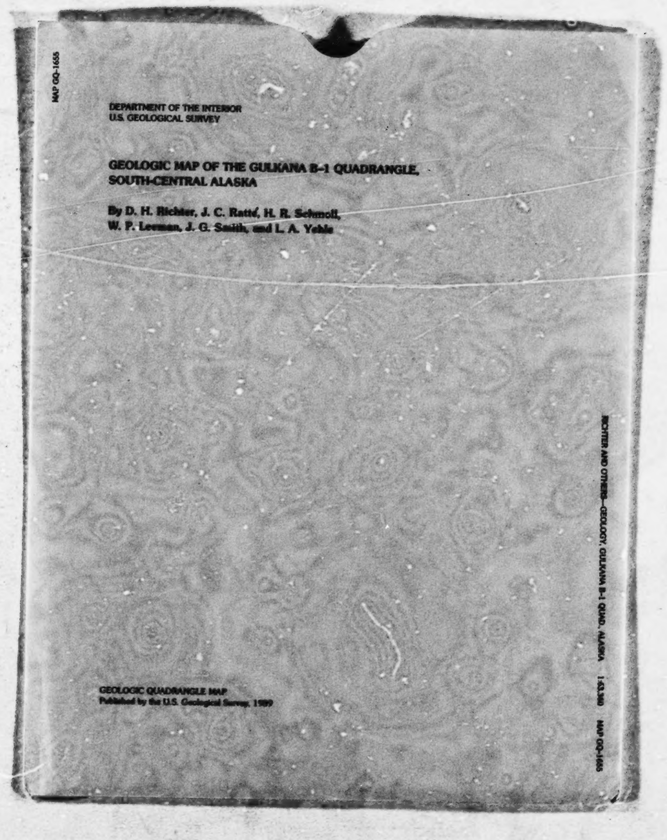
MAP GQ-1655
DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY
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By D. H. Richter, J. C. Reed, H. R. Schmoll, W. P. Leeman, J. G. Smith, and L. A. Yehle
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GEOLOGIC MAP SYMBOLS

COMMONLY USED ON MAPS OF THE UNITED STATES GEOLOGICAL SURVEY

(Special symbols are shown in explanation)

Contact – Dashed where approximately located; short dashed where inferred; dotted where concealed

Contact – Showing dip; well exposed at triangle

Fault – Dashed where approximately located; short dashed where inferred; dotted where concealed

Fault, showing dip – Bar and ball on downthrown side

Normal fault – Hachured on downthrown side

Fault – Showing relative horizontal movement

Thrust fault – Sawteeth on upper plate

Anticline – Showing direction of plunge; dashed where approximately located; dotted where concealed

Asymmetric anticline – Short arrow indicates steeper limb

Overturned anticline – Showing direction of dip of limbs

Syncline – Showing direction of plunge; dashed where approximately located; dotted where concealed

Asymmetric syncline – Short arrow indicates steeper limb

Overturned syncline – Showing direction of dip of limbs

Monocline – Showing direction of plunge of axis

Minor anticline – Showing plunge of axis

Minor syncline – Showing plunge of axis

Strike and dip of beds – Ball indicates top of beds known from sedimentary structures

Inclined · Horizontal

Vertical · Overturned

Strike and dip of foliation

Inclined · Vertical · Horizontal

Strike and dip of cleavage

Inclined · Vertical · Horizontal

Bearing and plunge of lineation

Inclined · Vertical · Horizontal

Strike and dip of joints

Inclined · Vertical · Horizontal

Note: planar symbols (strike and dip of beds, foliation or schistosity, and cleavage) may be substituted with linear symbols to record data observed at same locality by superimposed symbols at point of observation. Coinciding planar symbols are shown intersecting at point of observation.

Shafts

Vertical · Inclined

Adit, tunnel, or slope

Accessible · Inaccessible

Prospect

Quarry

Active · Abandoned

Gravel pit

Active · Abandoned

Oil well

Drilling · Shut-in · Dry hole abandoned

Gas · Show of gas

Oil · Show of oil

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